5.4.9 Subsidence

History

Subsidence occurs when the original land surface elevation drops due to changes in the subsurface. Causes of subsidence include, but are not limited to, removal of fluids (water, oil, gas, etc.), mine collapse, and hydrocompaction. Of these causes, hydrocompaction and mine collapse tend to be localized events, while fluid removal may occur either locally or regionally. The main cause for subsidence in Arizona is excessive groundwater withdrawal (i.e., discharge exceeds recharge). Once an area has subsided, the ground elevation will not rise again, even if the pumped groundwater is replaced.

Subsidence causes regional drainage patterns to change, which impacts flooding, backs up storm drains, and damages infrastructure both in the subsurface (water and electric lines, well casings, etc.) and surface (roads, canals, drainages, surveyed benchmarks, etc.). Subsidence also causes fissures, which are discussed in this section as well.

Land-use areas that are predominantly agricultural tend to experience the most intense subsidence because of irrigation. However, subsidence is not restricted to rural areas—exponential population growth also places great demands on groundwater.

Some of the areas affected by subsidence include:

- Pinal County
  - Eloy—625 mi^2 (square miles) subsided 15 feet between 1948 and 1985
  - Stanfield—425 mi^2 subsided 12 feet by 1977
  - Apache Junction/Queen Creek—230 mi^2 subsided 3 feet by 1977
- Maricopa County
  - Luke Air Force Base—140 mi^2 subsided 3 feet by 1977
  - East Mesa—5.2 feet of subsidence
  - Paradise Valley—5 feet subsided between 1965 and 1982
  - Scottsdale—CAP canal subsided about 1 foot since construction
- Pima County
  - Avra Valley—northeast of Tucson
- La Paz County
  - Harquahala Plain
- Cochise County
  - Willcox—areas to the northwest and southeast
  - Bowie
  - San Simon

On September 20, 1992, a storm that generated four inches of surface runoff occurred north of Luke Air Force Base, and because of subsidence, a flow-reversal occurred in the Dysart Drain. The base was closed for three days with the runways and 100 homes flooded, incurring $3 million in damage.

Map 29

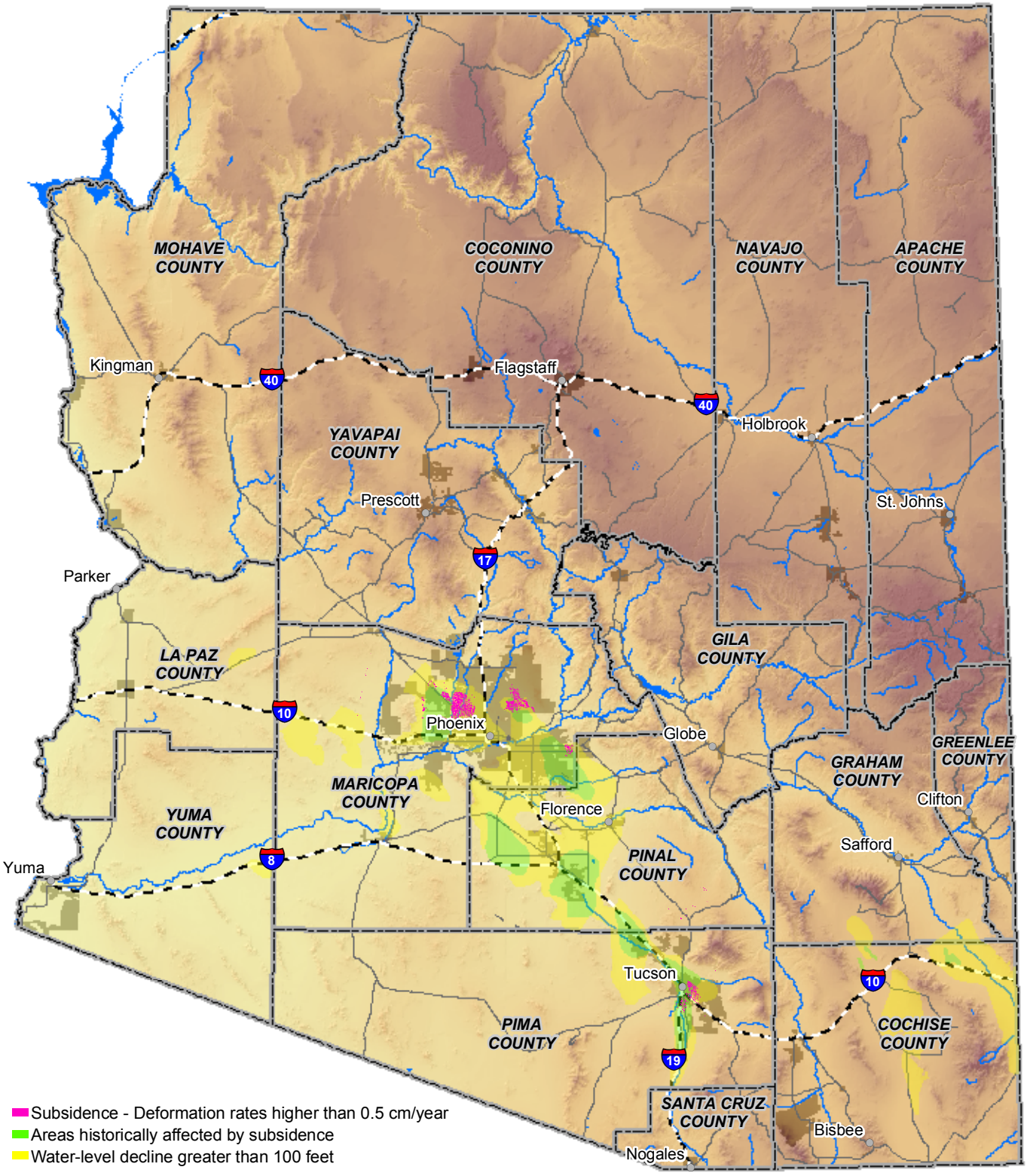
Areas represented have experienced subsidence and may be considered susceptible to subsidence in the future. In the areas shown, it is reasonable to expect subsiding to occur at the rate of 0.5 cm or more a year. Maricopa County has two areas of subsidence, one in the northeast and the other in the northwest. In Pima County, an area northeast of Tucson is affected.

Probability and Magnitude

Because of the complexity of the factors associated with subsidence areas, there are no recommended procedures to quantifiably determine the probability and magnitude of future subsidence. The following map shows the subsidence areas in Arizona, which are also considered susceptible to future subsidence. As long as groundwater discharge exceeds recharge, subsidence will occur. Even once equilibrium is reached, a period of 5-10 years will pass before the ground finishes subsiding.

In an attempt to categorize the probability of future subsidence events, the hazard was analyzed using the CPRI. This method also takes into account the levels of magnitude/severity, warning time and duration. In Arizona, subsidence is possible, the magnitude/severity is typically negligible, the warning time is less than 6 hours and the duration is usually less than 6 hours. These factors resulted in a CPRI rating of 1.9. The highest rating a hazard can result in using this method is 4.

State of Arizona



Source: HAZUS99; ALRIS 2006; USGS 1999; URS 2003

Legend

- Major City
- interstate
- Highway
- Major Streams
- County
- Lakes
- Cities

N

0 25 50

Miles

August 2007

State of Arizona Multi-Hazard Mitigation Plan

Map 29
Subsidence Affected Areas
thru 2007

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Vulnerability

The impacts and costs due to subsidence is related to loss of property and infrastructures damaged by receding groundwater tables and drought conditions, due to over-pumping generally in the south central part of Arizona. This area is considered one the fastest growing areas in the state with many new developments built every year. Therefore, as the area continues to be blanketed with developments, more impacts can be anticipated due to subsidence. The impact of subsidence can continue to be summarized by "fissures" as discussed above.

- 1992, on Luke Air Force base in Glendale, Maricopa County, up to 18 feet of subsidence and related earth fissures have been recorded. This led to a significant increase in local flooding and the flow reversal of the Dysart Drain, an engineered flood control device. On September 20, 1992, a rainstorm caused 4 inches of surface runoff that closed the base for 3 days. The Dysart Drain spilled over due to sluggish flow, flooding the runways and 100 homes, resulting in approximately $3 million worth of damages.

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